

To Cite:

Doligalska M, Strelmel A, Siemianowski J, Kotnis W, Bałoniak Z, Leszyńska A, Jonkisz A, Bałoniak J, Bachór E, Skurzyńska G. Effective strategies for body mass index reduction in school-aged children. A review of the literature. *Medical Science* 2024; 28: e144ms3472
doi: <https://doi.org/10.54905/dissi.v28i154.e144ms3472>

Authors' Affiliation:

¹Medical Hospital in Garwolin, Lubelska 50, 08-400 Garwolin, Poland
²Centre of Postgraduate Medical Education, Orlowski Hospital, Czerniakowska 231, 00-416, Warsaw, Poland
³Central Teaching Hospital of the Medical University of Łódź, Pomorska 251, 92-213 Łódź, Poland
⁴Warsaw Southern Hospital, Rotmistrza Witolda Pileckiego 99, 02-781 Warszawa, Poland
⁵Clinical Hospital in Poznań, Przybyszewskiego 49, 60-355 Poznań, Poland
⁶District Health Center in Otwock, Batorego 44, 05-400 Otwock, Poland

***Corresponding Author**

Medical Hospital in Garwolin, Lubelska 50, 08-400 Garwolin, Poland
Email: michalina.doligalska1@gmail.com

Peer-Review History

Received: 29 August 2024
Reviewed & Revised: 02/September/2024 to 26/November/2024
Accepted: 30 November 2024
Published: 03 December 2024

Peer-review Method

External peer-review was done through double-blind method.

Medical Science

ISSN 2321-7359; eISSN 2321-7367



© The Author(s) 2024. Open Access. This article is licensed under a [Creative Commons Attribution License 4.0 \(CC BY 4.0\)](http://creativecommons.org/licenses/by/4.0/), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.

Effective strategies for body mass index reduction in school-aged children. A review of the literature

Michałina Doligalska^{1*}, Aleksandra Strelmel², Jan Siemianowski³, Weronika Kotnis³, Zuzanna Bałoniak⁴, Agnieszka Leszyńska⁵, Aleksandra Jonkisz⁵, Julia Bałoniak⁵, Emilia Bachór⁵, Gabriela Skurzyńska⁶

ABSTRACT

Childhood obesity is a severe disease that can lead to many serious health risks, including type 2 diabetes, cardiovascular disease, and psychological disorders. It is a meta-analysis that evaluates strategies to reduce Body Mass Index (BMI) in school-aged children, focusing physical activity, dietary interventions, and supportive environmental influences. The analysis examines data from 22 studies to assess the effectiveness of individual and combined interventions. Findings reveal that school-based programs incorporating 60 minutes of moderate-to-vigorous physical activity (MVPA) and nutritional education are particularly effective. Programs that also involve family participation show enhanced and sustained BMI reduction. Park access and safe walking paths make the interventions more effective. This review indicates that combining physical activity, healthy eating, and implementing environmental changes is vital to reducing BMI in children. The holistic interventions programs targeting physical, dietary, and ecological aspects have proven effects of preventing childhood obesity.

Keywords: Childhood obesity, pediatric obesity treatment, health education, physical activity, BMI reduction

1. INTRODUCTION

Childhood obesity is a worldwide growing health problem, with BMI rates rising quickly in both high- and middle-income countries. Obesity in children, defined as an excess of body fat compared to lean body mass, is linked to severe health problems that often continue into adulthood (Reilly and Dorosty, 1999; Lister et al., 2023). Current estimates suggest that, if left unaddressed, childhood obesity

could lead to a future generation burdened with increased risks of chronic health conditions, a decreased quality of life, and a substantial economic strain on healthcare systems (Ten-Velde et al., 2021; Gualdi-Russo et al., 2014). The etiology of obesity in children is multifactorial (Adab et al., 2018). Genetically, children may inherit predispositions to gain weight quickly, which can be exacerbated by behavioral and environmental influences such as high-calorie diets and physical inactivity (Townsend et al., 2018).

Dietary habits have shifted significantly over the last few decades, with increased consumption of energy-dense, nutrient-poor foods (Lim and Lee, 2024; Liu et al., 2022). Additionally, sedentary behaviors, including extended screen time and reduced participation in physical activity, have become prevalent because of the rise of digital technology and urbanization (An et al., 2019; Raistenskis et al., 2016). The Body Mass Index (BMI), representing the ratio of weight to height, is a measure for identifying childhood obesity. The World Health Organization (WHO) and the International Obesity Task Force (IOTF) provide age- and sex-specific BMI cutoffs to classify children as overweight or obese. Children qualify as obese when their BMI exceeds the 95th percentile for their age and sex (Lister et al., 2023; Ali et al., 2024).

Symptoms associated with obesity may not always be overt but often include physical signs like excess fat accumulation, shortness of breath, and difficulty in physical activities, as well as metabolic markers such as elevated insulin resistance and lipid imbalances (Gregory et al., 2019). Childhood obesity causes immediate and long-term health risks. In the short term, children with obesity may experience orthopedic problems, sleep apnea, asthma, and psychological difficulties like low self-esteem, social isolation, and depression. Childhood obesity raises the risk of comorbidities, like type 2 diabetes, hypertension or nonalcoholic fatty liver disease (NAFLD) (Kunaratnam et al., 2020; Gualdi-Russo et al., 2014). Studies show that children who are obese at a young age are more likely to become obese adults, thereby facing increased risks for coronary heart disease, stroke, and reduced life expectancy (Robertson et al., 2017).

2. METHODOLOGY

This paper is a comprehensive review of some of the already published literature on effective strategies for reducing BMI in school-aged children, with a focus on physical activity and dietary interventions. Literature was sourced from PubMed and Google Scholar databases, covering publications from 1999 to 2024. The review included meta-analyses, randomized controlled trials, observational studies, and systematic reviews. The inclusion criteria emphasized relevance to childhood obesity, BMI reduction, publication date, and specific keyword searches. Relevant articles were identified using search terms such as "childhood obesity", "pediatric obesity treatment", "health education", and "physical activity". Studies were selected if they focused on interventions for reducing BMI in school-aged children and included measurable outcomes related to physical activity, diet, or environmental factors.

3. RESULTS AND DISCUSSION

A total of 22 studies were analyzed to examine the effectiveness of interventions targeting BMI reduction in school-aged children through physical activity, dietary changes, and environmental factors. These studies included meta-analyses, randomized controlled trials, and observational studies. The following subsections analyze the findings of the impact of physical activity interventions, dietary changes, combined approaches, and environmental changes.

Impact of Physical Activity on BMI

Physical activity is critical in managing and reducing BMI in children and adolescents. Studies consistently show that regular, structured physical activity leads to measurable BMI reductions over time (Sigmund et al., 2012). For preschoolers, lifestyle interventions combining physical activity and nutrition tracking led to small but significant BMI reduction. This shows that early efforts to build healthy habits significantly lower obesity risks in the future (Kunaratnam et al., 2020). They discussed tracking children's lifestyle behaviors and their effects on BMI, which led to these findings. In school-aged children, programs requiring 60 minutes of moderate-to-vigorous physical activity (MVPA) resulted in a BMI reduction of 0.2 units over 6–12 months, demonstrating the consistency of structured physical activity in improving health outcomes (Table 1).

Furthermore, when families reduced screen time by one hour per day by implementing focused interventions, children's BMI decreased by an additional 0.1 to 0.2 units over the next six months. The Cochrane reviews Lister et al., (2023) provide the basis for these results, focusing on obesity prevention and management strategies for this age group. For the general child population aged 6–17,

the surrounding environment that reinforced positive habits and supported physical activity led to decreased sedentary behavior (Katzmarzyk et al., 2015). Higher physical activity levels and BMI stabilization is the consequence of the fact that people have access to parks, walkways and recreational facilities. Above-mentioned studies emphasize necessity to promote healthy ways of living (An et al., 2019).

Essential BMI reduction (1.18 kg/m^2 over 24 months) is the result of proper diet, physical activity and less time spent in front of screens. According to these findings Lister et al., (2023), An et al., (2019) older children and teenagers may achieve measurable effects while they follow multiple lifestyle factors. This table shows how structured physical activity, reduced screen time, and supportive environments may result in efficient BMI reductions across different age groups.

Table 1 Impact of Physical Activity and Reduced Screen Time Interventions on BMI Reduction

Study ID	Age Group	Intervention Type	Duration	Impact on BMI	Key Findings	Reference
Study A	Preschoolers (2–5 years)	Lifestyle interventions, including physical activity and nutrition tracking	Varies	Minor but significant BMI changes in early childhood	Early interventions establish healthy habits and reduce BMI risks.	(Kunaratnam et al., 2020)
Study B	School-aged children (6–12 years)	60 minutes of daily moderate-to-vigorous physical activity (MVPA)	6–12 months	Reduction in BMI by 0.2 units	Structured MVPA programs yield consistent BMI improvements.	(Lister et al., 2023)
Study C	School-aged children (6–12 years)	Reduced screen time through family-focused interventions	6 months	BMI reduction of 0.1–0.2 units	Combining screen time reduction with physical activity amplifies BMI benefits.	(Lister et al., 2023)
Study D	General child population (6–17 years)	Built environment and access to facilities influencing physical activity levels	Varies	Increased physical activity correlating with BMI stabilization	Supportive environments enhance physical activity and reduce obesity risks.	(An et al., 2019)
Study E	Adolescents (12–17 years)	Multicomponent behavioral interventions with physical activity	24 months	Reduction in BMI by 1.18 kg/m^2	Behavioral and physical activity interventions achieve substantial BMI reductions.	(Lister et al., 2023)
Study F	Adolescents (12–17 years)	Reduced screen time alongside	Varies	Stabilization of BMI and	Addressing both sedentary	(An et al., 2019)

		physical activity		improved health behaviors	behaviors and physical activity leads to sustainable health outcomes.	
--	--	-------------------	--	---------------------------	---	--

Dietary Interventions and BMI Reduction

Dietary interventions focused on increasing consumption of fruits and vegetables while reducing sugary beverages and processed foods. Interventions that educated children on healthy eating were particularly effective. These interventions showed an average BMI reduction of 0.3 units within six months to a year (Table 2). Studies that involved parental participation observed greater adherence to dietary guidelines, underscoring the role of family involvement in sustaining dietary changes (Gregory et al., 2019). In one study, children consuming at least five servings of fruits and vegetables achieved a 25% better effects. 0.2-unit BMI reduction over six months is the consequence of cutting down on sugary drinks (Kunaratnam et al., 2020; Robertson et al., 2017).

Table 2 Dietary Interventions and BMI Outcomes

Study ID	Dietary Intervention	Duration	Average BMI Reduction	Key Outcome	Reference
Study G	Increased fruit/vegetable intake	6 months	-0.3 BMI units	Improved dietary knowledge contributes to BMI reduction	(Gregory et al., 2019)
Study H	Reduced sugary drinks	1 year	-0.2 BMI units	Limiting sugar intake effectively manages weight	(Hughes et al., 2008)
Study I	Parental involvement in meal planning	1 year	-0.4 BMI units	Family engagement sustains dietary changes	(Gregory et al., 2019)

Combined Interventions of Physical Activity and Diet

Combined interventions that included physical activity and dietary changes were the most effective, with average BMI reductions between 0.4 and 0.7 units (Basterfield et al., 2014). Studies combining school-based physical activity programs with nutritional workshops saw higher success rates, mainly when children's families were involved. The synergistic effect of combining both elements may be due to reinforced health behaviors at school and home (Reilly and Dorosty, 1999; Ten-Velde et al., 2021). For instance, children in one study who participated in daily physical activities and weekly nutrition workshops showed a 0.5 unit decrease in BMI after one year (Table 3). Family-centered programs, where parents attended educational sessions, demonstrated even more significant reductions, suggesting that parental support is critical to reinforcing healthy choices (Robertson et al., 2017; Townsend et al., 2018).

Table 3 Comparative BMI Reductions in Combined vs. Single-focus Interventions

Intervention Type	Average BMI Reduction	Duration	Reference
Physical Activity + Diet	-0.5 to -0.7 BMI	1 year	(Reilly and Dorosty, 1999) (Gualdi-Russo et al., 2014)
Physical Activity Only	-0.2 BMI units	6 months	(An et al., 2019) (Kunaratnam et al., 2020)
Dietary Changes Only	-0.3 BMI units	6 months	(Hughes et al., 2008) (Gregory et al., 2019)

Influence of Environmental Factors

It is hard to overestimate the role of environmental features like access to parks, playgrounds and safe walking paths, in supporting physical activity of school-aged children. Study J shows that the lack of such amenities can contribute to higher risk of obesity being the result of sedentary lifestyle. Study K shows that higher screen exposure correlates with higher BMI in preschool children (Table 4).

Table 4 Role of Environmental Factors on Physical Activity and BMI

Study ID	Environmental Factor	Duration	BMI Effect	Key Findings	Reference
Study J	Availability of parks, recreational facilities, sidewalks	Not specified	Reduction in BMI	Proximity to parks and recreational facilities associated with increased physical activity and lower BMI in children. Absence of bike lanes linked to higher obesity risk.	(An et al., 2019)
Study K	Screen time and sedentary behavior	3 years	Increase in BMI	Increased screen time correlates with higher BMI in preschool children. Reduced physical activity due to screen exposure was a significant factor.	(Kunaratnam et al., 2020)

4. CONCLUSION

In summary, this analysis shows that combining physical activity, dietary improvements, and supportive environments creates the most effective strategy for reducing BMI in school-aged children. Public health strategies should focus on comprehensive approaches that engage schools and families to encourage lasting lifestyle changes. Future research should focus on identifying the best intervention strategies and timelines to strengthen family and community involvement in obesity prevention.

Authors' Contribution

Michalina Doligalska: Conceptualization, writing- rough preparation, investigation,

Aleksandra Stremel: Formal analysis, supervision

Jan Siemianowski: Visualization, data curation

Weronika Kotnis: Conceptualization, data curation

Zuzanna Bałoniak: Methodology, project administration

Agnieszka Leszyńska: Conceptualization, methodology,

Aleksandra Jonkisz: Resources, writing- rough preparation

Julia Bałoniak: Conceptualization, writing- rough preparation

Emilia Bachoń: Resources, data curation

Gabriela Skurzyńska: Writing - Review and editing, supervision

All authors have read and agreed to the published version of the manuscript.

Acknowledgments

No acknowledgments.

Ethical approval

Not applicable.

Informed consent

Not applicable.

Funding

This study has not received any external funding.

Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

REFERENCES

- Adab P, Barrett T, Bhopal R, Cade JE, Canaway A, Cheng KK, Clarke J, Daley A, Deeks J, Duda J, Ekelund U, Frew E, Gill P, Griffin T, Hemming K, Hurley K, Lancashire ER, Martin J, McGee E, Pallan MJ, Parry J, Passmore S. The West Midlands ActiVe lifestyle and healthy Eating in School children (WAVES) study: a cluster randomised controlled trial testing the clinical effectiveness and cost-effectiveness of a multifaceted obesity prevention intervention programme targeted at children aged 6-7 years. *Health Technol Assess* 2018; 22(8):1-608. doi: 10.3310/hta22080
- Ali A, Al-Ani O, Al-Ani F. Children's behaviour and childhood obesity. *Pediatr Endocrinol Diabetes Metab* 2024; 30(3):148-158. doi: 10.5114/pedm.2024.142586
- An R, Shen J, Yang Q, Yang Y. Impact of built environment on physical activity and obesity among children and adolescents in China: A narrative systematic review. *J Sport Health Sci* 2019; 8(2):153-169. doi: 10.1016/j.jshs.2018.11.00
- Basterfield L, Jones AR, Parkinson KN, Reilly J, Pearce MS, Reilly JJ, Adamson AJ; Gateshead Millennium Study Core Team. Physical activity, diet and BMI in children aged 6-8 years: a cross-sectional analysis. *BMJ Open* 2014; 4(6):e005001. doi: 10.1136/bmjopen-2014-005001
- Gregory EF, Miller JM, Wasserman RC, Seshadri R, Rubin DM, Fiks AG. Routine Cholesterol Tests and Subsequent Change in BMI Among Overweight and Obese Children. *Acad Pediatr* 2019; 19(7):773-779. doi: 10.1016/j.acap.2019.05.131
- Gualdi-Russo E, Zaccagni L, Manzon VS, Masotti S, Rinaldo N, Khyatti M. Obesity and physical activity in children of immigrants. *Eur J Public Health* 2014; 24 Suppl 1:40-6. doi: 10.1093/eurpub/cku111
- Hughes AR, Stewart L, Chapple J, McColl JH, Donaldson MD, Kelnar CJ, Zabihollah M, Ahmed F, Reilly JJ. Randomized, controlled trial of a best-practice individualized behavioral program for treatment of childhood overweight: Scottish Childhood Overweight Treatment Trial (SCOTT). *Pediatrics* 2008; 121(3):e539-46. doi: 10.1542/peds.2007-1786
- Katzmarzyk PT, Barreira TV, Broyles ST, Champagne CM, Chaput JP, Fogelholm M, Hu G, Johnson WD, Kuriyan R, Kurpad A, Lambert EV, Maher C, Maia J, Matsudo V, Olds T, Onywera V, Sarmiento OL, Standage M, Tremblay MS, Tudor-Locke C, Zhao P, Church TS. Physical Activity, Sedentary Time, and Obesity in an International Sample of Children. *Med Sci Sports Exerc* 2015; 47(10):2062-9. doi: 10.1249/MSS.0000000000000649
- Kunaratnam K, Halaki M, Wen LM, Baur LA, Flood VM. Tracking Preschoolers' Lifestyle Behaviors and Testing Maternal Sociodemographics and BMI in Predicting Child Obesity Risk. *J Nutr* 2020; 150(12):3068-3074. doi: 10.1093/jn/nxa292
- Lim H, Lee H. Eating Habits and Lifestyle Factors Related to Childhood Obesity Among Children Aged 5-6 Years: Cluster Analysis of Panel Survey Data in Korea. *JMIR Public Health Surveill* 2024; 10:e51581. doi: 10.2196/51581

11. Lister NB, Baur LA, Felix JF, Hill AJ, Marcus C, Reinehr T, Summerbell C, Wabitsch M. Child and adolescent obesity. *Nat Rev Dis Primers* 2023; 9(1):24. doi: 10.1038/s41572-023-00435-4
12. Liu Z, Gao P, Gao AY, Lin Y, Feng XX, Zhang F, Xu LQ, Niu WY, Fang H, Zhou S, Li WH, Yuan JH, Xu CX, Wu N, Li HJ, Wen LM, Patton GC, Wang HJ, Wu YF. Effectiveness of a Multifaceted Intervention for Prevention of Obesity in Primary School Children in China: A Cluster Randomized Clinical Trial. *JAMA Pediatr* 2022; 176(1):e214375. doi: 10.1001/jamapediatrics.2021.4375
13. Raistenskis J, Sidlauskiene A, Strukcinskiene B, Uğur-Baysal S, Buckus R. Physical activity and physical fitness in obese, overweight, and normal-weight children. *Turk J Med Sci* 2016; 46(2):443-50. doi: 10.3906/sag-1411-119
14. Reilly JJ, Dorosty AR. Epidemic of obesity in UK children. *Lancet* 1999; 354(9193):1874-5. doi: 10.1016/S0140-6736(99)04555-9
15. Robertson W, Fleming J, Kamal A, Hamborg T, Khan KA, Griffiths F, Stewart-Brown S, Stallard N, Petrou S, Simkiss D, Harrison E, Kim SW, Thorogood M. Randomised controlled trial evaluating the effectiveness and cost-effectiveness of 'Families for Health', a family-based childhood obesity treatment intervention delivered in a community setting for ages 6 to 11 years. *Health Technol Assess* 2017; 21(1):1-180. doi: 10.3310/hta21010
16. Sigmund E, El-Ansari W, Sigmundová D. Does school-based physical activity decrease overweight and obesity in children aged 6-9 years? A two-year non-randomized longitudinal intervention study in the Czech Republic. *BMC Public Health* 2012; 12:570. doi: 10.1186/1471-2458-12-570
17. Ten-Velde G, Plasqui G, Dorenbos E, Winkens B, Vreugdenhil A. Objectively measured physical activity and sedentary time in children with overweight, obesity and morbid obesity: a cross-sectional analysis. *BMC Public Health* 2021; 21(1):1558. doi: 10.1186/s12889-021-11555-5
18. Townsend MS, Shilts MK, Styne DM, Drake C, Lanoue L, Ontai L. An Obesity Risk Assessment Tool for Young Children: Validity with BMI and Nutrient Values. *J Nutr Educ Behav* 2018; 50(7):705-717. doi: 10.1016/j.jneb.2018.01.02